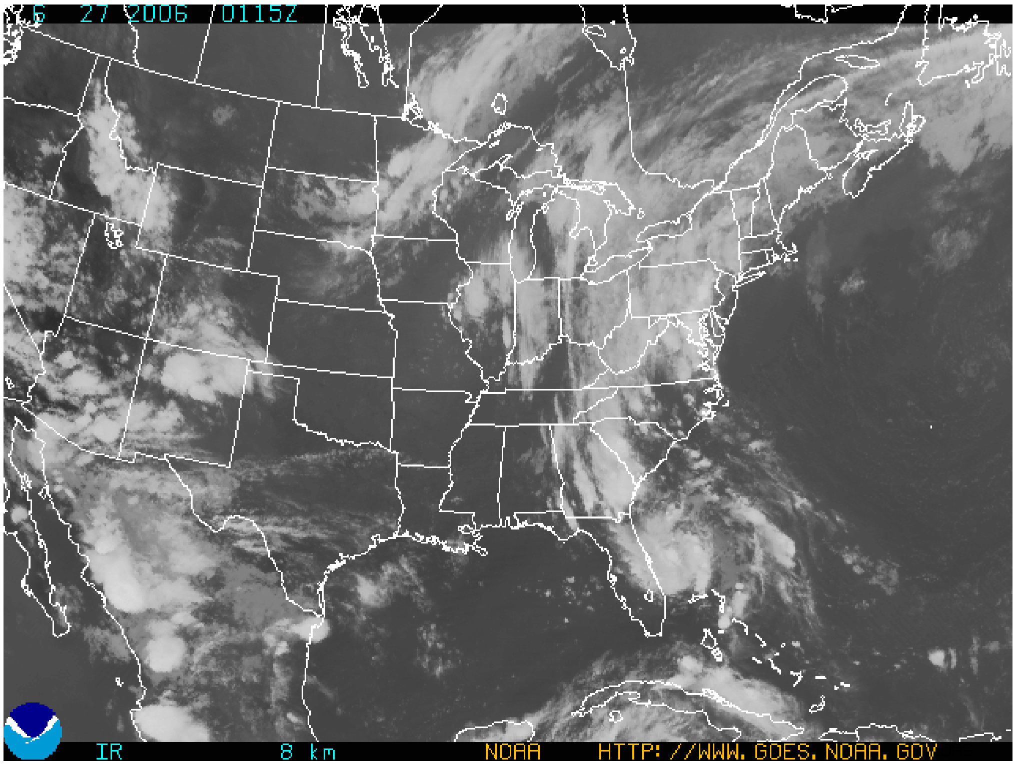
A PRELIMINARY REPORT ON THE EFFECTS OF THE JUNE 27 – 28, 2006 TROPICAL DISTURBANCE ON WATER LEVELS ALONG THE MID-ATLANTIC COAST



Revised July 12, 2006

noaa **National Oceanic and Atmospheric Administration**

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

CO-OPS Water Level Data for the Tropical Disturbance

The NOAA Center for Operational Oceanographic Products and Services (CO-OPS) maintains a network of water level stations along the United States coastline to closely monitor water level activity. During the hurricane season (June through November) stations along the Gulf and Southeast/East coasts provide especially useful information in the event of a Hurricane or Tropical Storm.

On June 27 at 0730 EDT (1130 GMT) the National Hurricane Center issued a Special Tropical Disturbance Statement, warning that a small low pressure system with the potential to develop into a tropical depression was in formation about 140 miles south of Cape Fear, North Carolina. By June 28 1215 EDT (0415 GMT) the disturbance was already moving across the Chesapeake Bay bringing gale force winds and thunderstorms to the area; however, it was poorly organized and swept through the area to merge with a frontal zone later that day. Satellite images show the passage of the disturbance over 36 hours (June 27 0115 GMT to June 28 1315 GMT, the 24th hour showing the disturbance over the Chesapeake Bay). During this time a front had stalled on the East Coast as well, bringing several inches of rainfall to the Chesapeake and Delaware Bay area. Radar images illustrate precipitation intensity from both systems.

These two events caused elevated water levels, triggering high water advisory reports on Tides Online (Wilmington, NC (8658120), Philadelphia, PA (8548989) and Reedy Point, DE (8551910)). Philadelphia, PA remained triggered due to high water levels until July 3. Flash flood watches and warnings were issued from the Carolinas to New England beginning June 25. Several stations from North Carolina to New Jersey that reflect these elevated water levels along with peak elevations are displayed in this report. Peak elevations reached 0.562 m (1.84 ft) in Oregon Inlet Marina, NC, 0.748 m (2.45 ft) in Lewisetta, VA, 0.753 m (2.47 ft) in Solomons Island, MD, 0.944 m (3.10 ft) in Tolchester Beach, MD and Baltimore, MD, and 2.875 m (9.43 ft) in Philadelphia, PA, all substantially higher than predicted levels. Observed low water levels exceeded predicted high water elevations in Newbold, PA (8548989) and Burlington, NJ (8539094). In addition, United States Geological Survey (USGS) gauges recorded high water flows on or near the Potomac, Susquehanna and Delaware Rivers around the time of the disturbance.

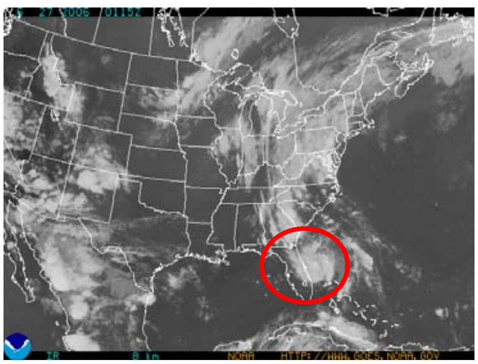
SPECIAL TROPICAL
DISTURBANCE STATEMENT
730 AM EDT TUE JUN 27 2006

SATELLITE AND RADAR INFORMATION INDICATE THAT A SMALL LOW PRESSURE SYSTEM COULD BE FORMING ABOUT 140 MILES SOUTH OF CAPE FEAR NORTH CAROLINA. THIS SYSTEM HAS THE POTENTIAL TO DEVELOP INTO A TROPICAL DEPRESSION AT ANY TIME AS IT MOVES NORTH TO NORTH-NORTHEASTWARD AT 15 TO 20 MPH.

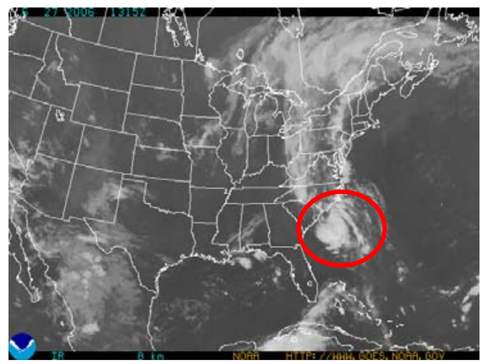
SPECIAL TROPICAL
DISTURBANCE STATEMENT
1215 AM EDT WED JUN 28 2006

SURFACE OBSERVATIONS INDICATE THAT GALE FORCE WINDS ARE OCCURRING OVER PORTIONS OF CHESAPEAKE BAY AS THE LOW CENTER MOVES ACROSS THE BAY. HOWEVER...THE LOW HAS LIMITED AND POORLY ORGANIZED THUNDERSTORM ACTIVITY. GALE WARNINGS ARE ALREADY IN PLACE FOR THE AFFECTED AREAS...PLEASE CONSULT PRODUCTS ISSUED BY YOUR LOCAL NWS FORECAST OFFICE CONCERNING GALE WARNINGS AND ANY RAINFALL AND/OR FLOOD STATEMENTS. THE LOW IS EXPECTED TO CONTINUE MOVING RAPIDLY NORTH-NORTHEASTWARD AND MERGE WITH A FRONTAL ZONE BY LATE TODAY.

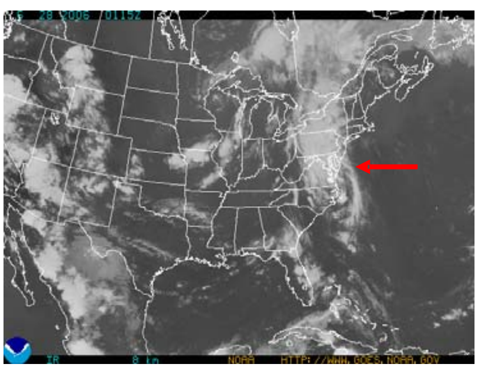
Figure 1: National Hurricane Center (NHC) advisories issued for June 27 1130 GMT (left) and June 28 0415 GMT (right).



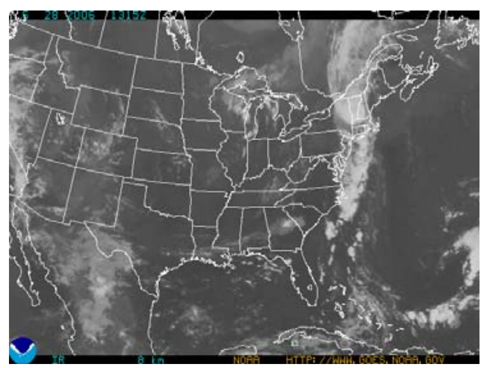
June 27 0115 GMT



June 27 1315 GMT

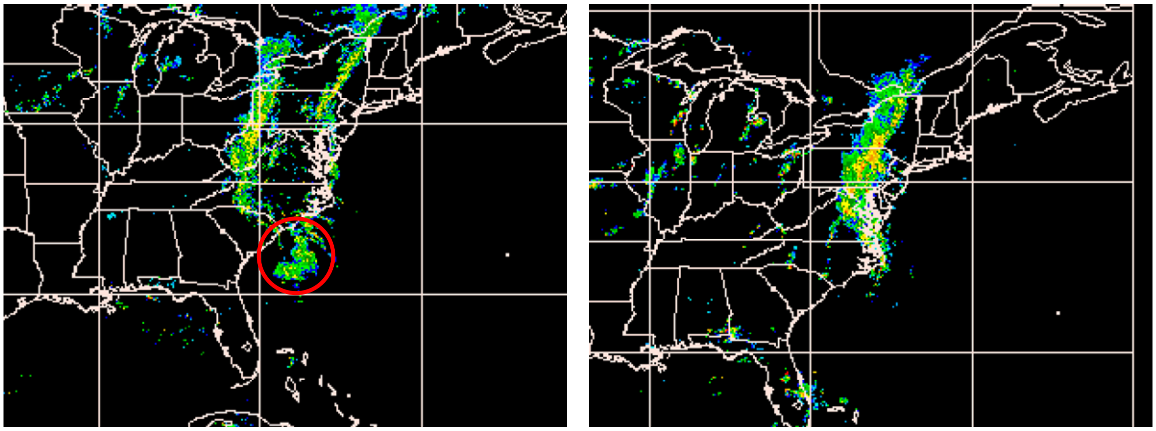


June 28 0115 GMT



June 28 1315 GMT

Figure 2. Infrared satellite images showing the progression of the disturbance 27-28 June (http://www.goes.noaa.gov). The tropical disturbance is highlighted with a red circle. The June 28 1315 GMT image indicates that the disturbance broke apart, as a distinct circulation is hard to detect.



June 27 1300 GMT June 28 0100 GMT

Figure 3. NEXRAD national mosaic reflectivity images for June 27 (left) and June 28 (right). The tropical disturbance is highlighted with a red circle on the June 27 image and is not indicated on the June 28 image as it was harder to discern from the stationary front. http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWNEXRAD~Images2.

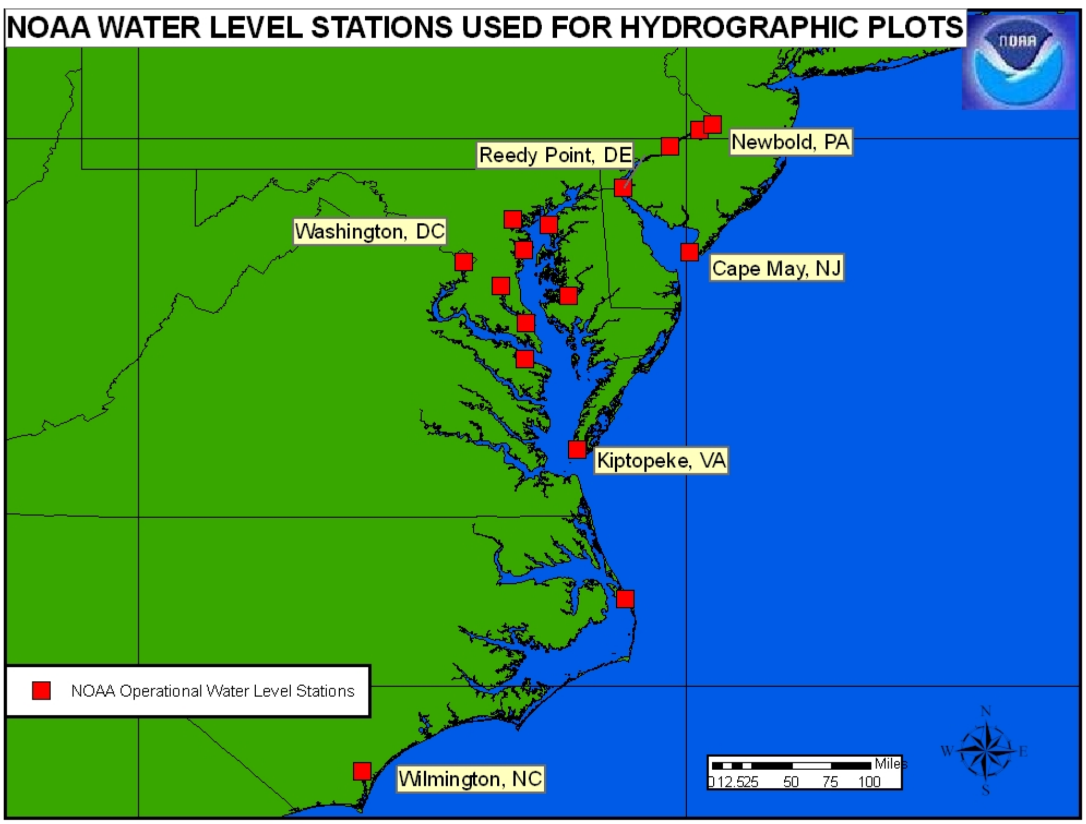


Figure 4. Map of NOAA water level stations that were used to plot hydrographs below (Figures 5 to 20). Stations extend along the Outer Banks up to the Delaware Bay.

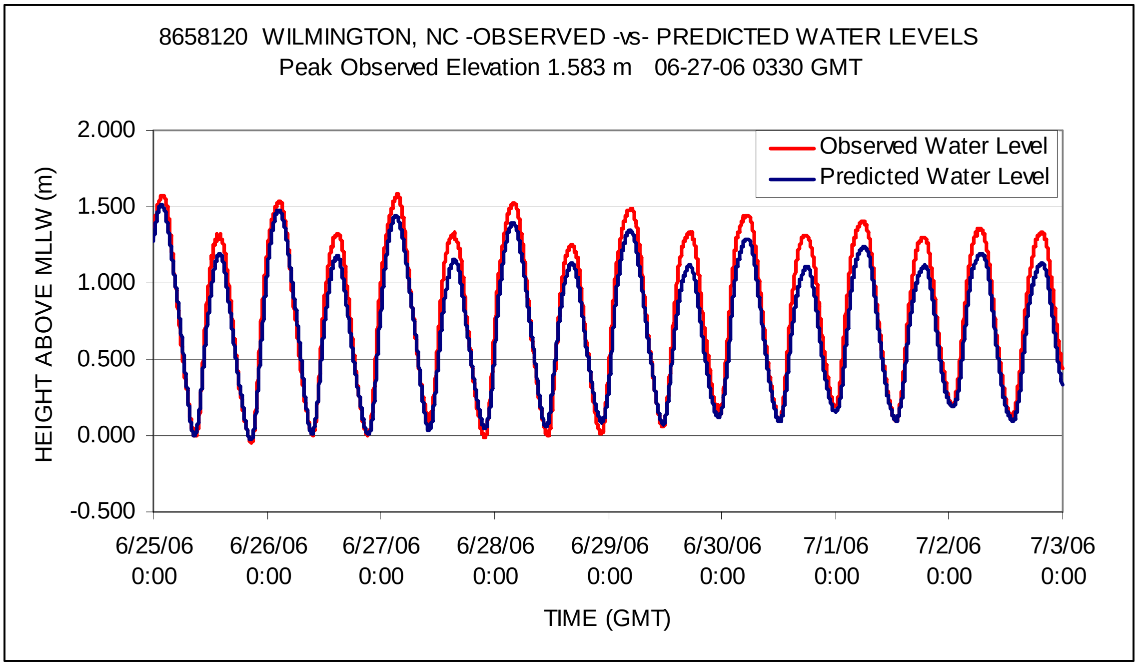


Figure 5. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Wilmington, NC.

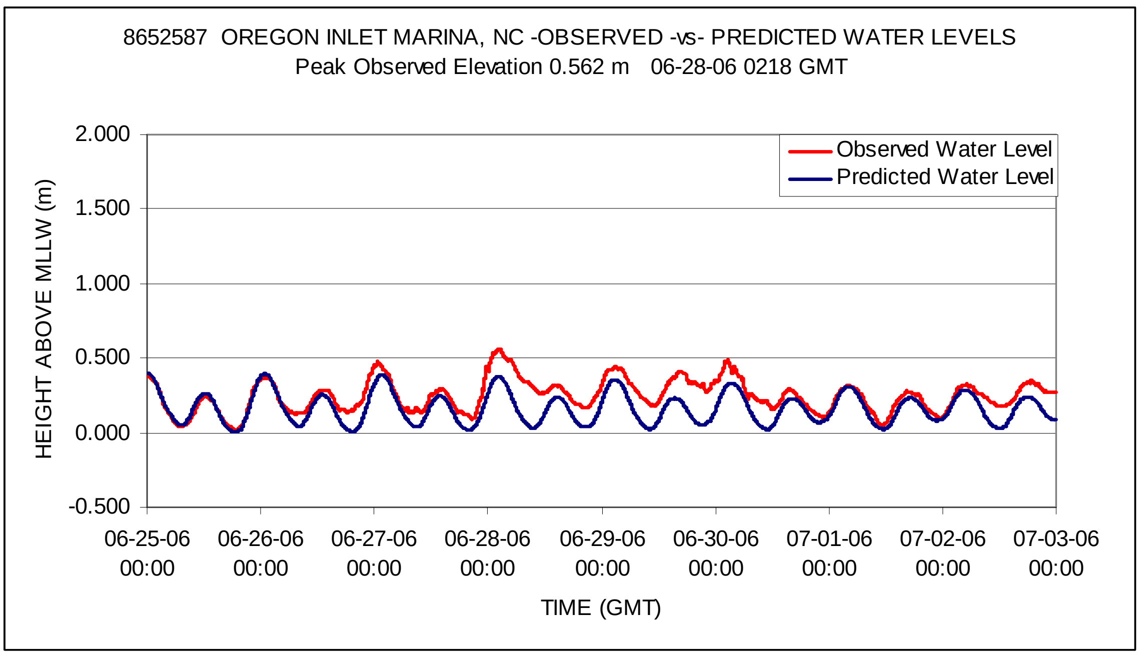


Figure 6. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Oregon Inlet Marina, NC.

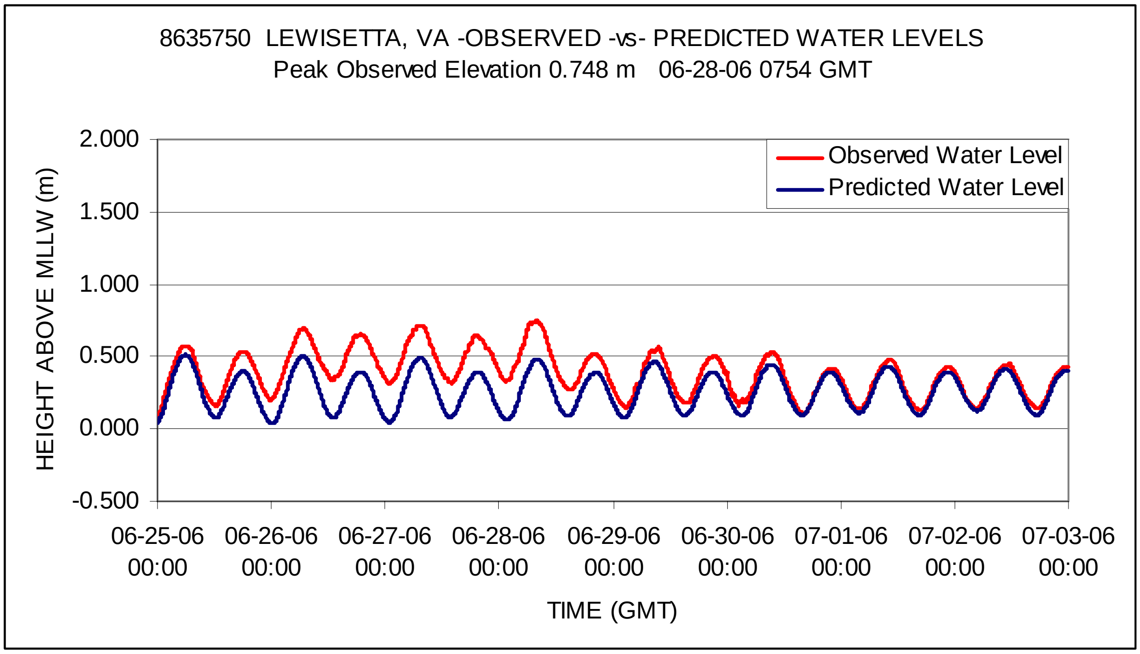


Figure 7. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Lewisetta, VA.

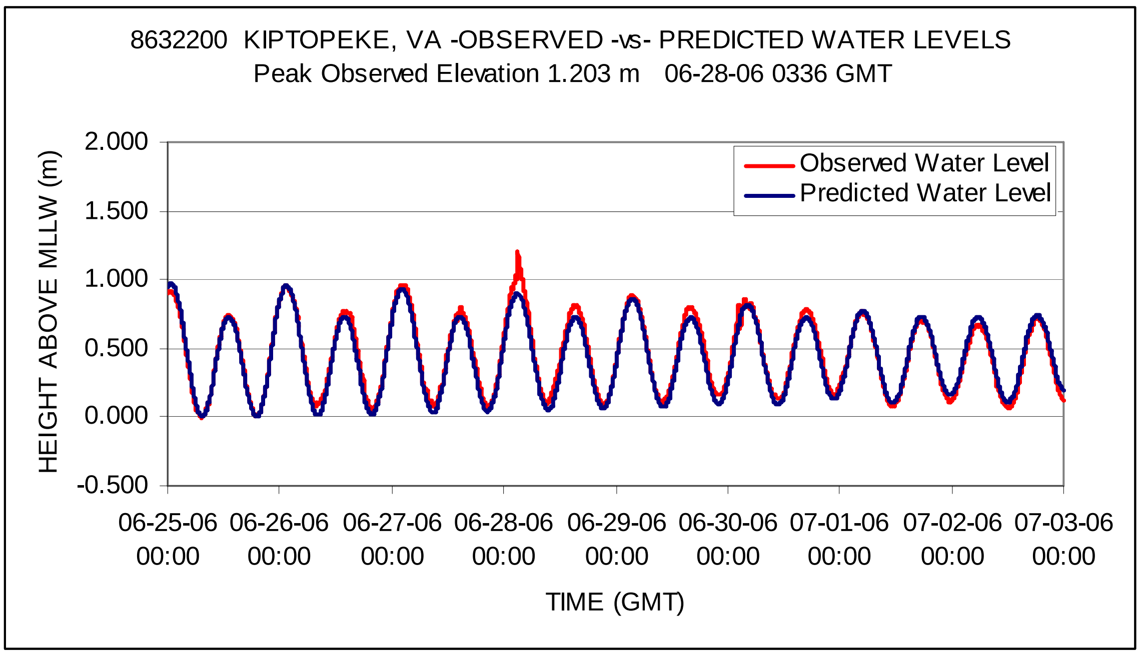


Figure 8. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Kiptopeke, VA.

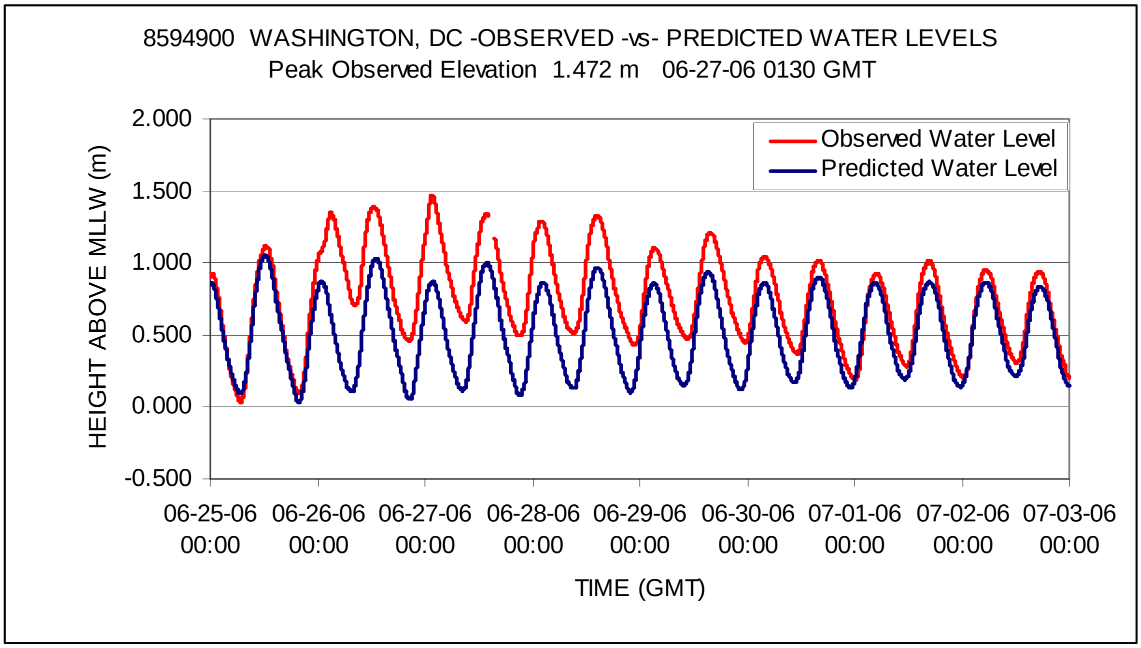


Figure 9. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Washington, DC.

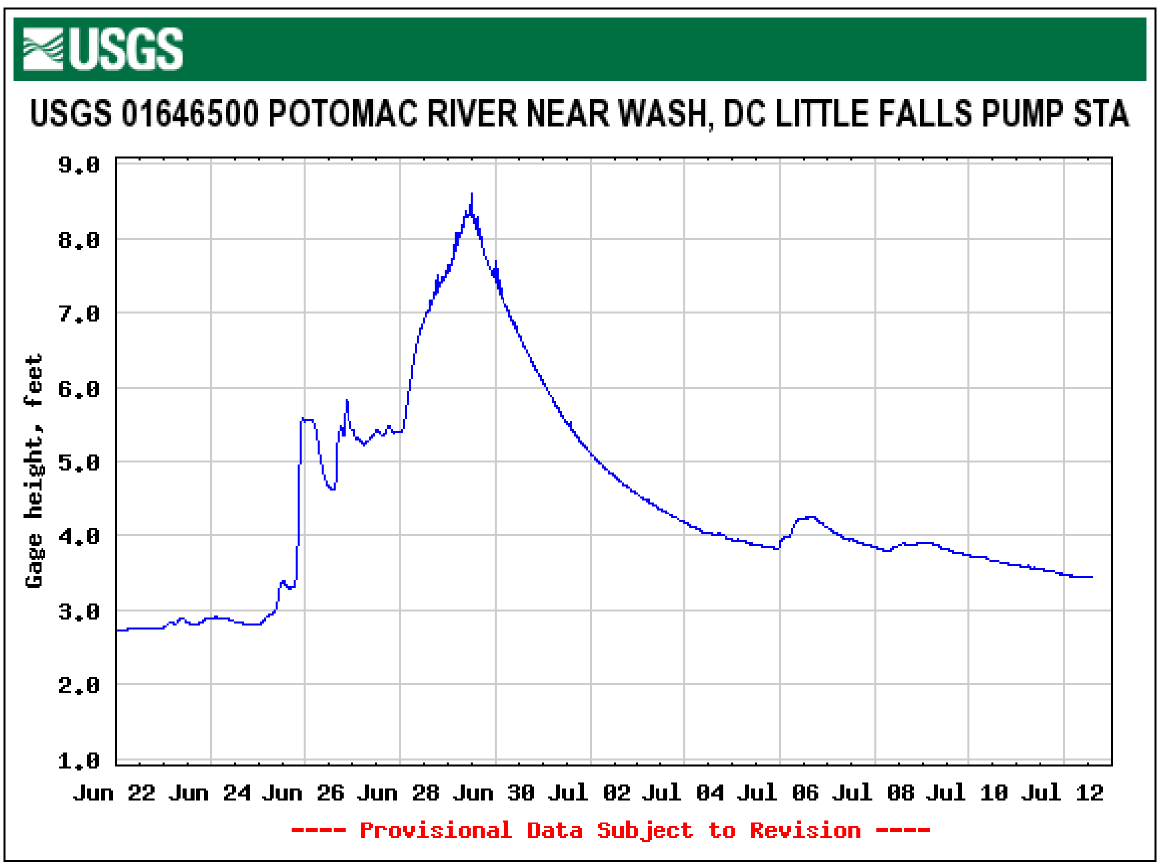


Figure 10. Gauge height, in feet and over Eastern Daylight Time.

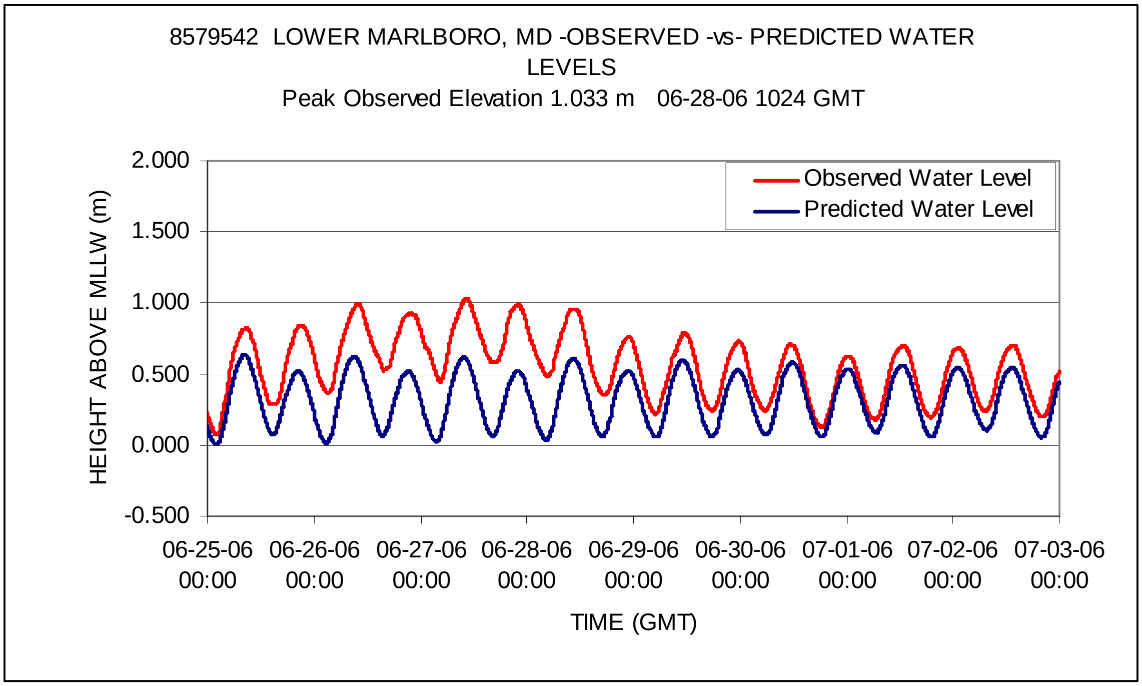


Figure 11. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Lower Marlboro, MD.

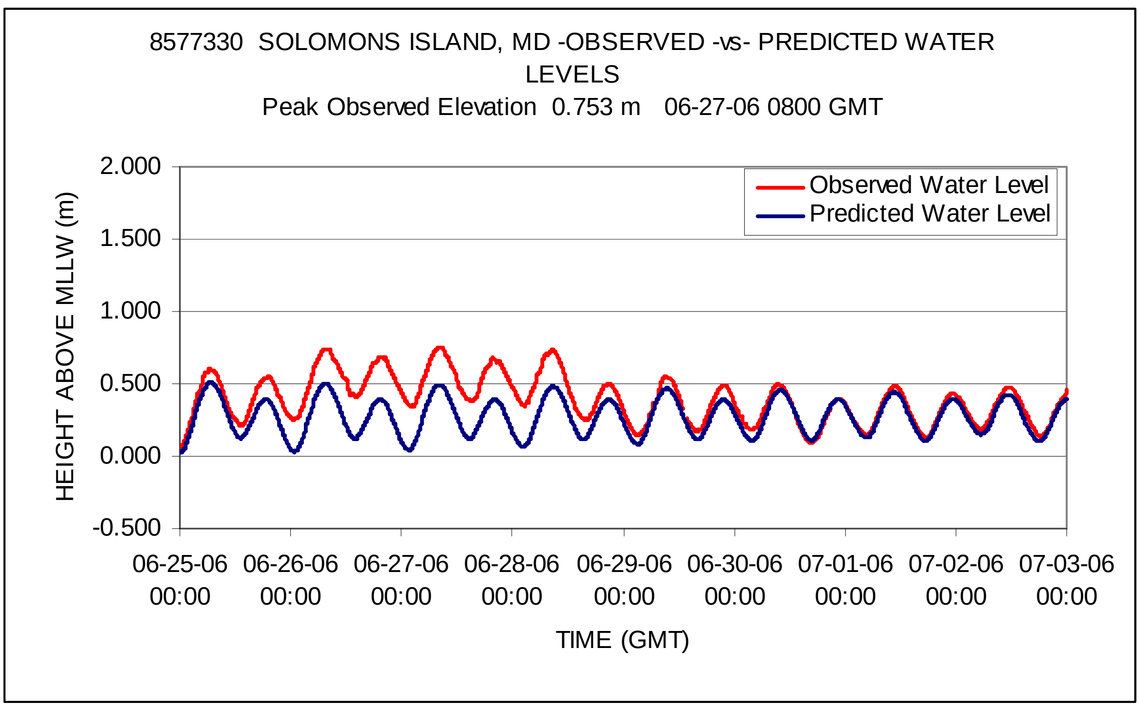


Figure 12. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Solomons Island, MD.

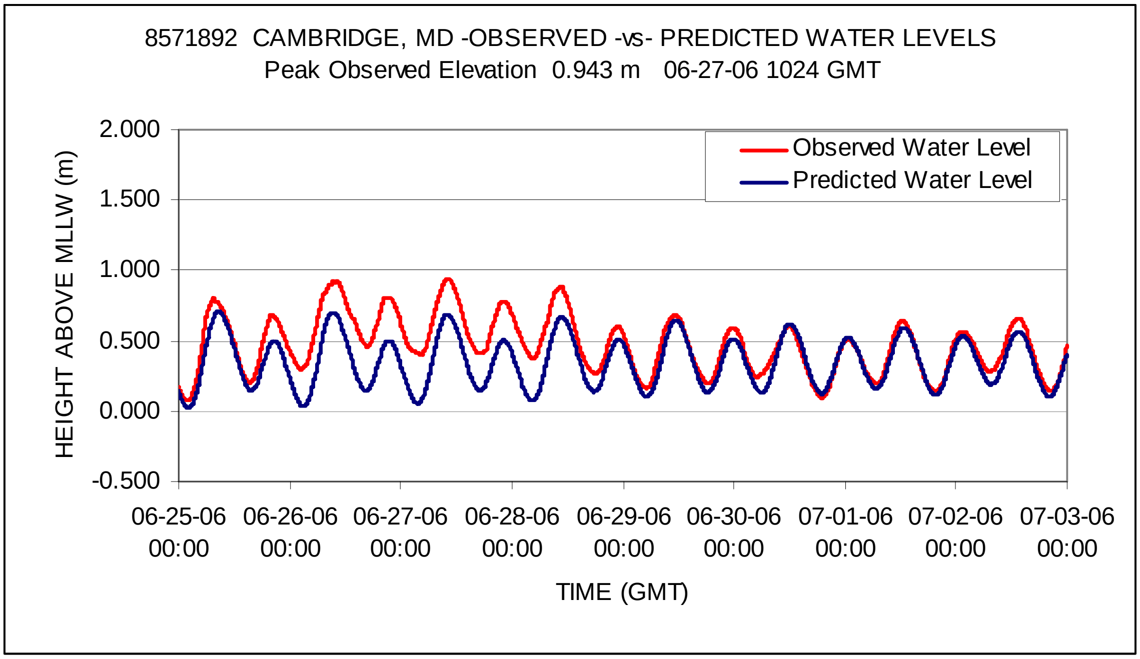


Figure 13. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Cambridge, MD.

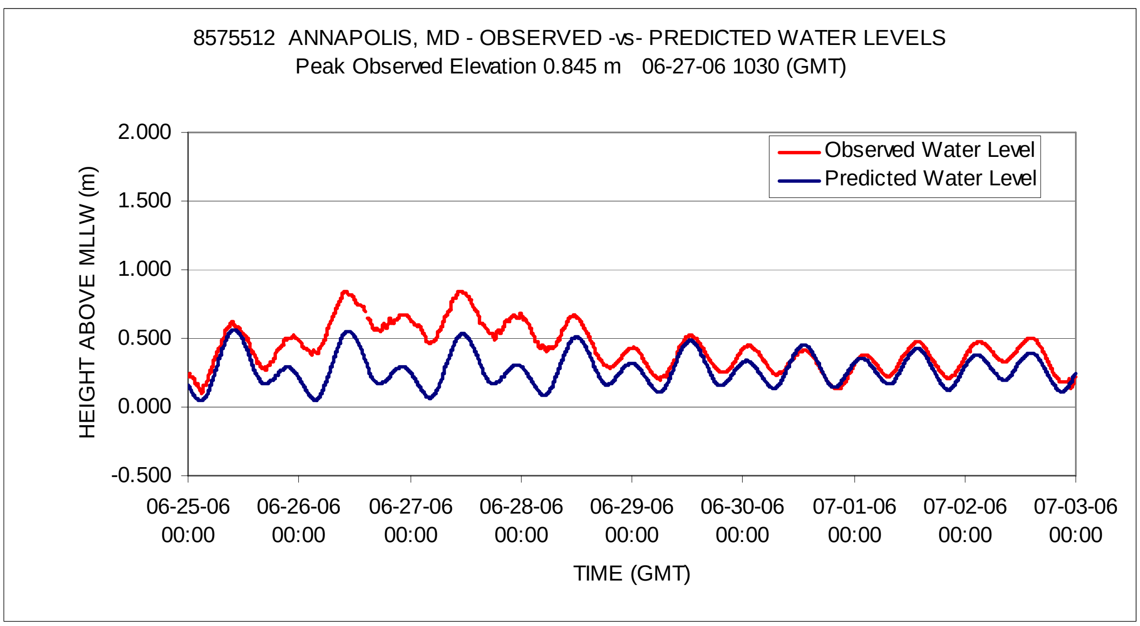


Figure 14. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Annapolis, MD.

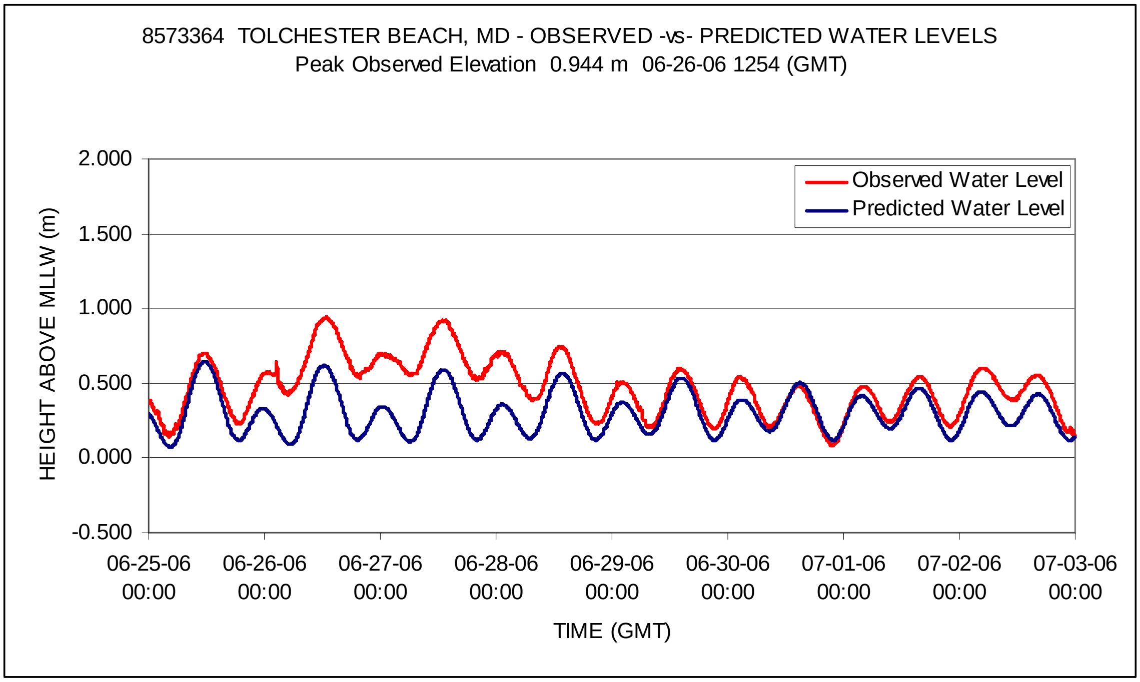


Figure 15. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Tolchester Beach, MD.

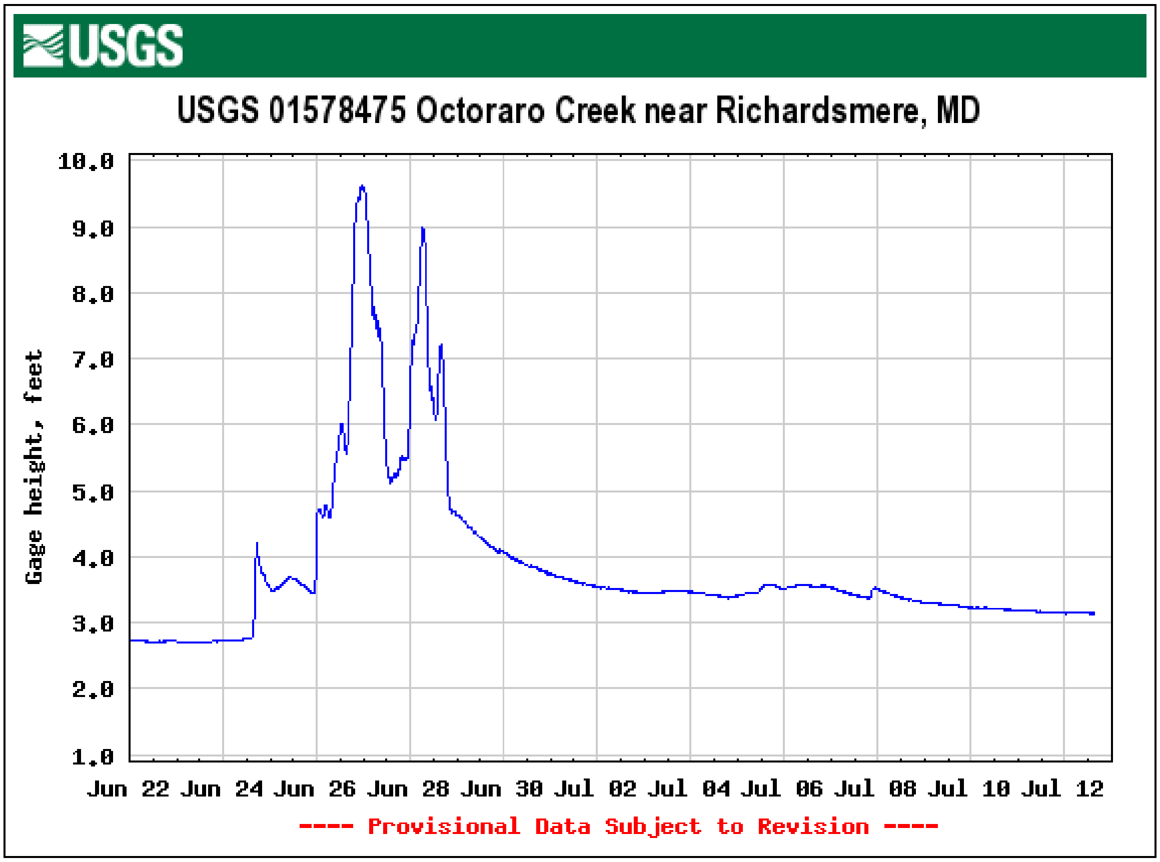


Figure 16. Gauge height, in feet and over Eastern Daylight Time. Octoraro Creek is at the head of the Susquehanna River.

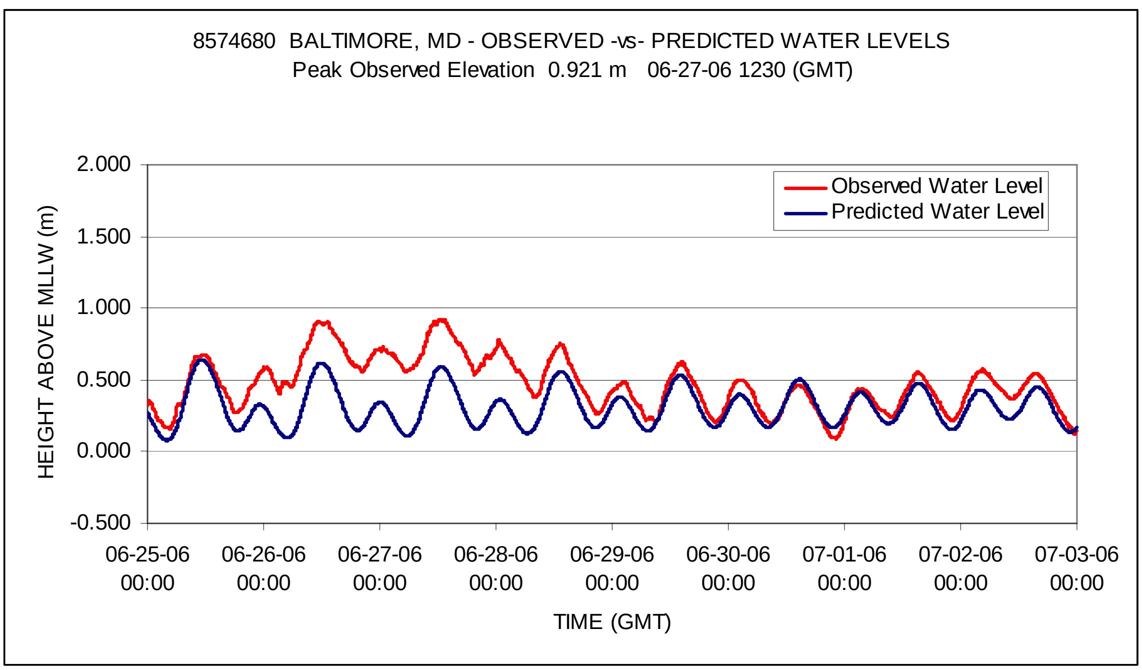


Figure 17. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Baltimore, MD.

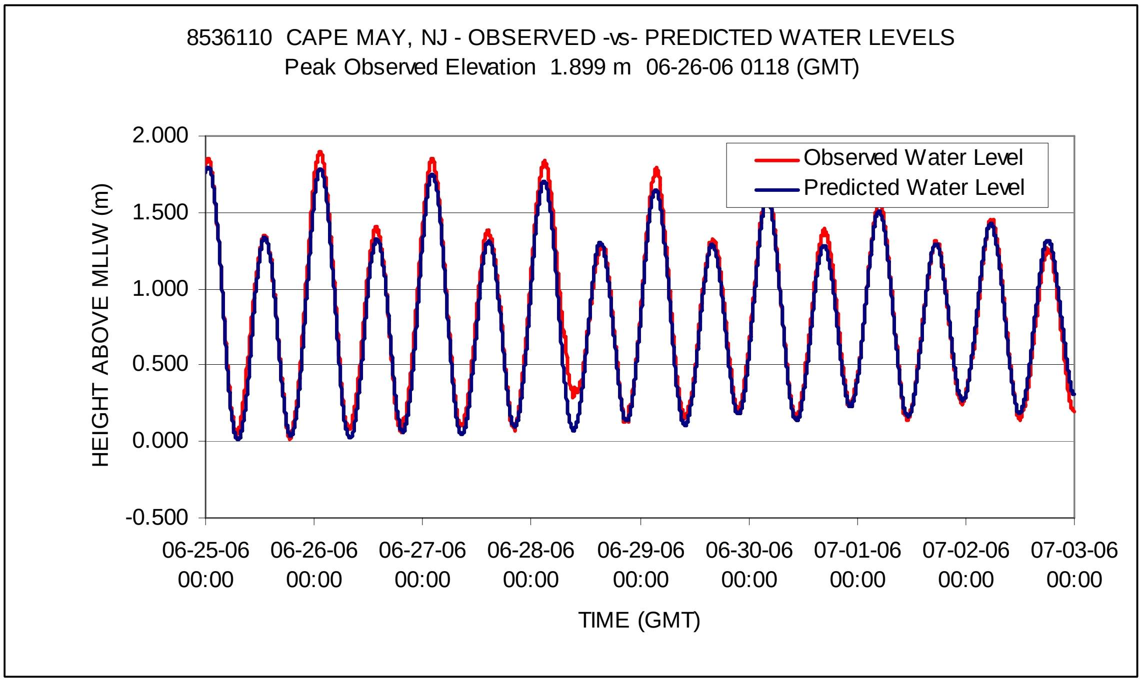


Figure 18. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Cape May, NJ.

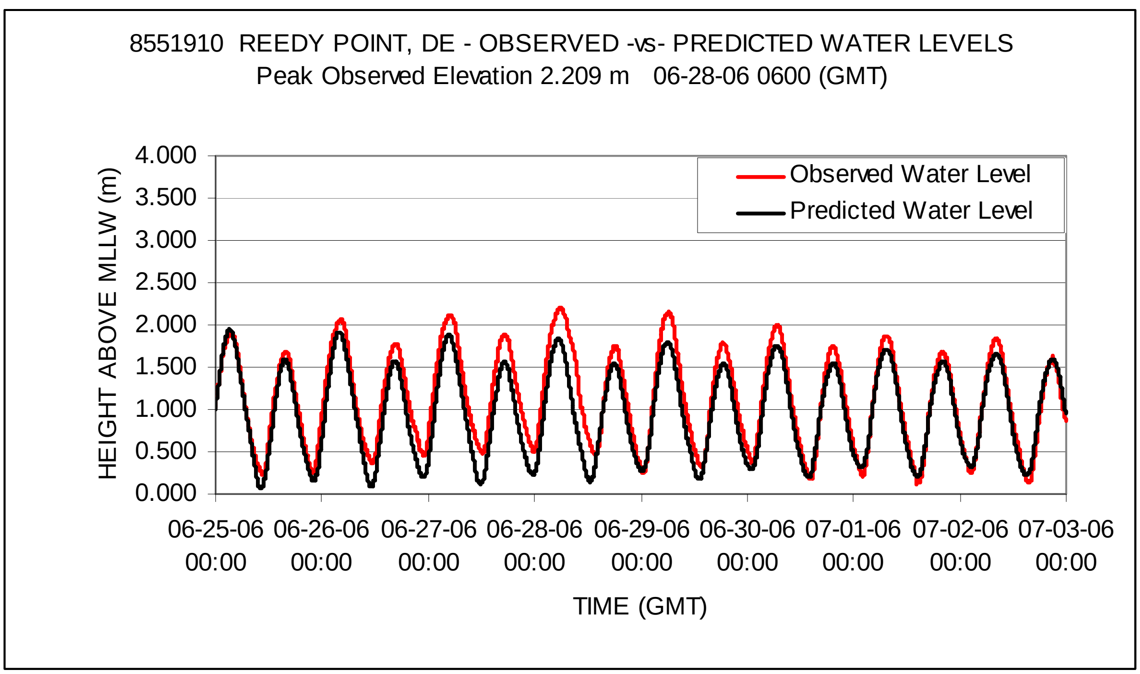


Figure 19. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Reedy Point, DE.

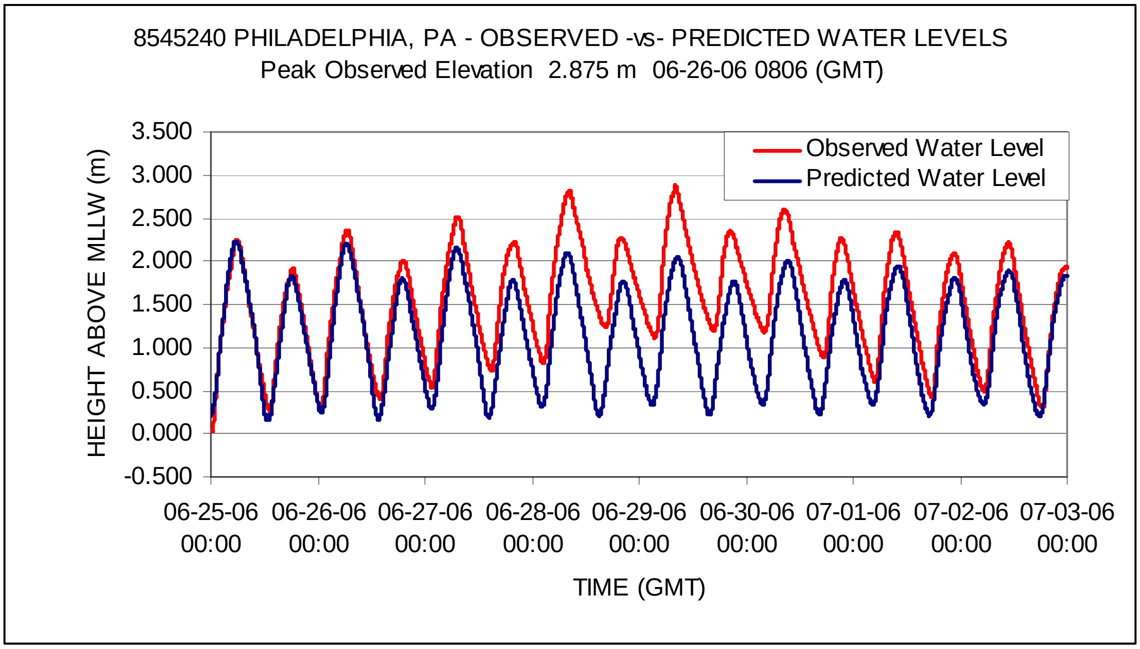


Figure 20. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Philadelphia, PA.

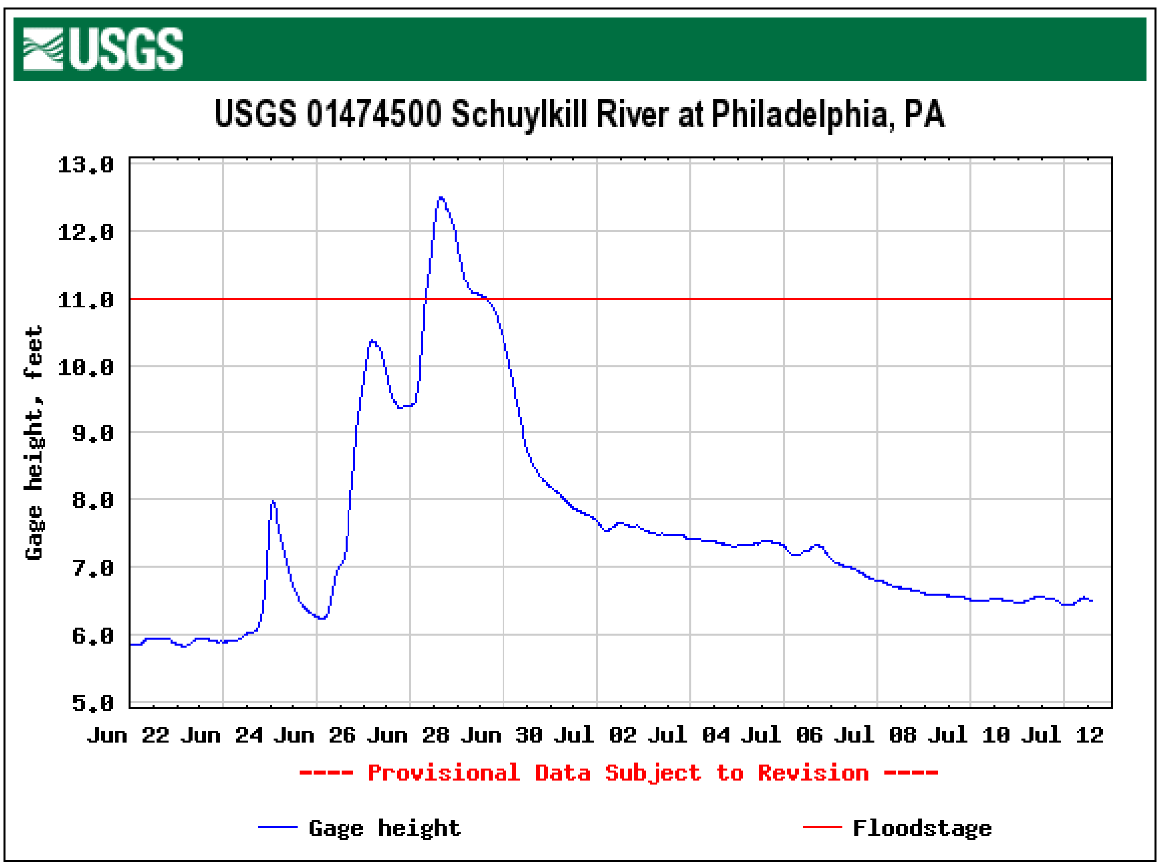


Figure 21. Gauge height, in feet and over Eastern Daylight Time.

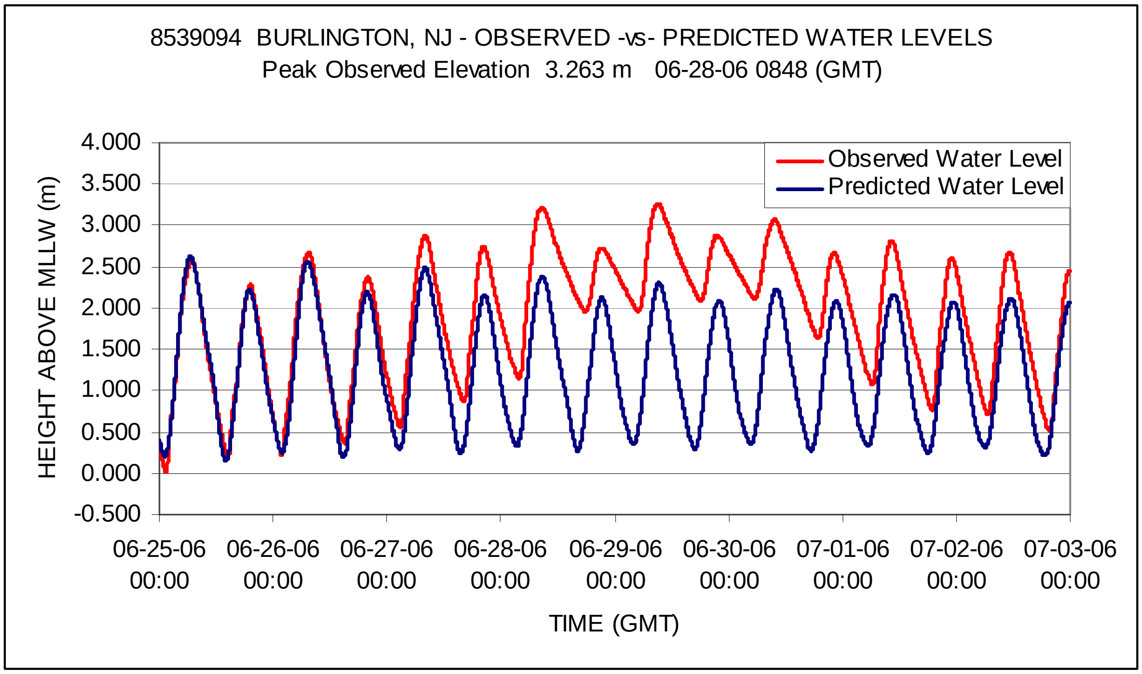


Figure 22. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Burlington, NJ.

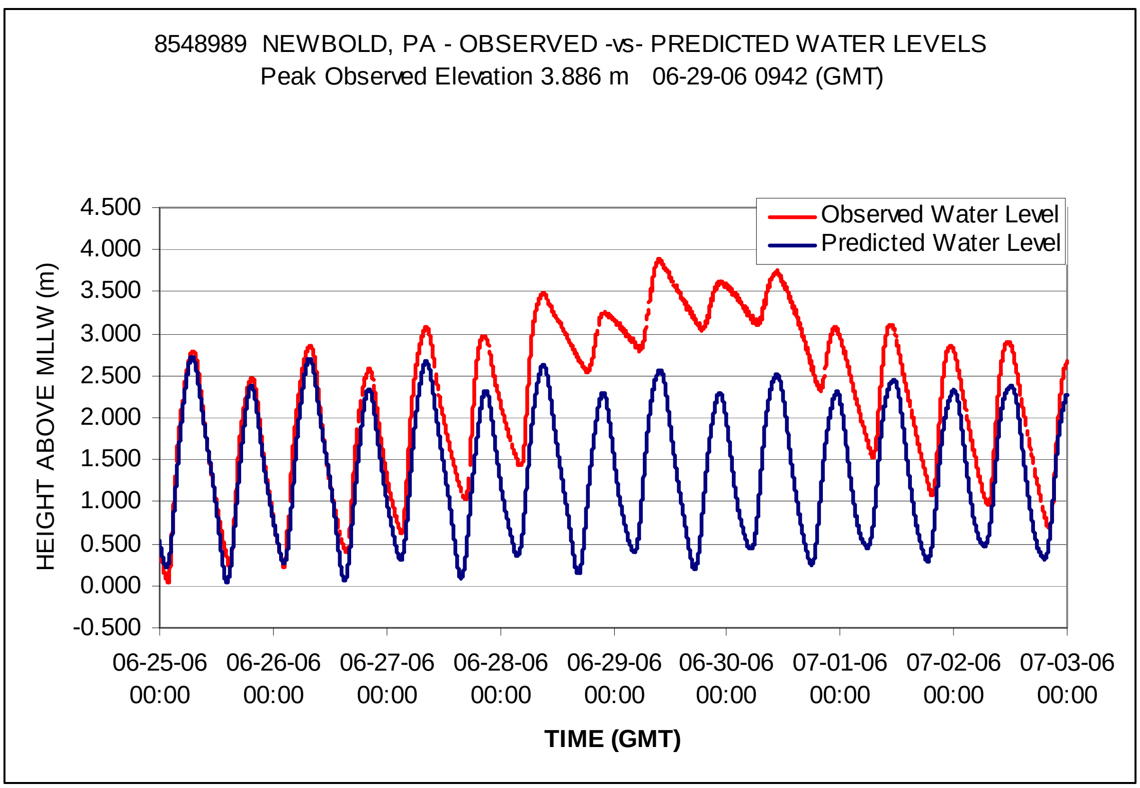


Figure 23. Time series of observed and predicted water levels above the tidal datum Mean Lower Low Water (MLLW) at Newbold, PA.

Appendix

Excerpt From:

Tide and Current Glossary, NOAA National Ocean Service, Silver Spring, MD, 2000.

tide: The periodic rise and fall of a body of water resulting from gravitational interactions between Sun, Moon, and Earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate this motion as tidal current. Same as astronomic tide.

tide (water level) gauge: An instrument for measuring the rise and fall of the tide (water level).

storm tide: As used by the National Weather Service, NOAA, the sum of the storm surge and astronomic tide. See storm surge and tide.

storm surge: The local change in the elevation of the ocean along a shore due to a storm. The storm surge is measured by subtracting the astronomic tidal elevation from the total elevation. It typically has a duration of a few hours. Since wind generated waves ride on top of the storm surge (and are not included in the definition), the total instantaneous elevation may greatly exceed the predicted storm surge plus astronomic tide. It is potentially catastrophic, especially on low lying coasts with gently sloping offshore topography. See storm tide.

National Water Level Observation Network (NWLON): The network of tide and water level stations operated by the National Ocean Service along the marine and Great Lakes coasts and islands of the United States.

datum (vertical): For marine applications, a base elevation used as a reference from which to reckon heights or depths. It is called a tidal datum when defined in terms of a certain phase of the tide. Tidal datums are local datums and should not be extended into areas which have differing hydrographic characteristics without substantiating measurements. In order that they may be recovered when needed, such datums are referenced to fixed points known as bench marks. See chart datum and bench marks.

chart datum: The datum to which soundings on a chart are referred. It is usually taken to correspond to a low-water elevation, and its depression below mean sea level is represented by the symbol Z_o. Since 1980, chart datum has been implemented to mean lower low water for all marine waters of the United States, its territories, Commonwealth of Puerto Rico, and Trust Territory of the Pacific Islands. See datum and National Tidal Datum Convention of 1980.

geodetic datum: See National Geodetic Vertical Datum of 1929 (NGVD 1929) and North American Vertical Datum of 1988 (NAVD 1988).

Mean Lower Low Water (MLLW): A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. See National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

National Tidal Datum Epoch: The specific l9-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level. The present National Tidal Datum Epoch is 1960 through 1978. It is reviewed annually for possible revision and must be actively considered for revision every 25 years.

National Tidal Datum Convention of 1980: Effective November 28, 1980, the Convention: (1) establishes one uniform, continuous tidal datum system for all marine waters of the United States, its territories, Commonwealth of Puerto Rico, and Trust Territory of the Pacific Islands, for the first time in history; (2) provides a tidal datum system independent of computations based on type of tide; (3) lowers chart datum from mean low water to mean lower low water along the Atlantic coast of the United States; (4) updates the National Tidal Datum Epoch from 1941 through 1959, to 1960 through 1978; (5) changes the name Gulf Coast Low Water Datum to mean lower low water; (6) introduces the tidal datum of mean higher high water in areas of predominantly diurnal tides; and (7) lowers mean high water in areas of predominantly diurnal tides. See chart datum.

National Geodetic Vertical Datum of 1929 [NGVD 1929]: A fixed reference adopted as a standard geodetic datum for elevations determined by leveling. The datum was derived for surveys from a general adjustment of the first-order leveling nets of both the United States and Canada. In the adjustment, mean sea level was held fixed as observed at 21 tide stations in the United States and 5 in Canada. The year indicates the time of the general adjustment. A synonym for Sea-level Datum of 1929. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because there are many variables affecting sea level, and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level is not consistent from one location to another in either time or space. For this reason, the National Geodetic Vertical Datum should not be confused with mean sea level. See North American Vertical Datum of 1988 (NAVD 1988).

North American Vertical Datum of 1988 [NAVD 1988]: A fixed reference for elevations determined by geodetic leveling. The datum was derived from a general adjustment of the first-order terrestrial leveling nets of the United States, Canada, and Mexico. In the adjustment, only the height of the primary tidal bench mark, referenced to the International Great Lakes Datum of 1985 (IGLD 1985) local mean sea level height value, at Father Point, Rimouski, Quebec, Canada was held fixed, thus providing minimum constraint. NAVD 1988 and IGLD 1985 are identical. However, NAVD 1988 bench mark values are given in Helmert orthometric height units while IGLD 1985 values are in dynamic heights. See International Great Lakes Datum of 1985, National Geodetic Vertical Datum of 1929, and geopotential difference.

bench mark (BM): A fixed physical object or mark used as reference for a horizontal or vertical datum. A tidal bench mark is one near a tide station to which the tide staff and tidal datums are referred. A primary bench mark is the principal mark of a group of tidal bench marks to which the tide staff and tidal datums are referred.

For further information on tides, tidal predictions, tidal datums and related publications, contact:

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